

## **TITLE OF THE INVENTION**

Toilet and Urinal Leak Detection and Warning System and Method

## **CROSS REFERENCE TO RELATED APPLICATIONS**

The Applicant claims the benefit of his provisional application #60/462,211 filed  
5 on April 11, 2003.

## **BACKGROUND OF THE INVENTION**

The present invention relates to a system for monitoring an operating toilet or  
urinal, in order to provide a user with a warning indication of a condition of failure,  
specifically the passing of water through the internal plumbing for a duration longer or  
10 shorter than planned, such that the user may undertake the necessary remedial  
actions.

Flush toilets are designed with a flush mechanism which is made up of a tank  
reservoir which when flushed release the water contained via gravity feed to force the  
waste through displacement to pass through the wastewater plumbing (soil or sewer  
15 line). The tank reservoir includes an apparatus which detects the water level in the  
tank. As the water level in the tank falls, a valve is opened to allow water from an  
outside source to enter the tank. If there are no leaks allowing the water to exit the tank  
in the absence of a flush cycle, the tank will eventually fill to a level to satisfy the water  
level detector, typically a float device, which will cause the water inlet valve to close.

20 Occasionally, a failure occurs to impede the process of filling the tank reservoir.  
Some examples of common failures are: the flush mechanism fails to reseat resulting in  
an opening allowing water to continue to flow from the tank reservoir to the toilet bowl

after the flush cycle is complete; a leak between the toilet tank reservoir and the toilet bowl permitting water to escape the reservoir; a failure in the tank reservoir water level detector causing the water to continue to pass into the tank after the tank has reached a full level. Other failure modes include the short cycling of the toilet tank water valve which results from slow leaks somewhere in the mechanism. A leak in the system may allow the tank water level to reach a full level. However, occasional refreshing of the level will be required causing the refill cycle to be very short.

The current design of many millions of toilets will, under the conditions mentioned, continue to allow water to pass through the water inlet valve and through the tank reservoir until the condition repairs itself, or until it is noticed by someone who takes action to cause the continued water flow to cease. In some situations, a slow leak in the toilet reservoir may cause water inlet valve to recycle on a regular basis to keep the reservoir tank filled. In this failure mode, the water inlet valve will operate for a shorter period of time than normally would be associated to fill the tank when the tank is operating normally during a flush operation. Providing that an average toilet may pass up to two gallons of water per minute, a toilet which displays one or more of the aforementioned conditions may cause approximately 2500 to 3500 gallons of water to be wasted per day until the problem is detected and repaired.

In the case of urinals, a specially designed flush valve allows water to pass for a predetermined period of time. The water then rushes down the front face of the urinal through gravity feed to the bottom where it exits the drain. However, flush mechanisms are prone to stick in the open position allowing the water flow to continue well past the designed and intended duration.

## SUMMARY OF THE INVENTION

One object of the present invention is to provide a running water detector and warning system which indicates the continuous flow of water into a toilet tank reservoir, or down the face of a urinal, and gives an alarm signal to the users such that they may undertake the necessary remedial actions. It is also an object of the present invention to provide a means to detect short cycling of a water inlet valve in a toilet tank reservoir to provide an alarm to the users that there is a leak in the system causing a shorter than normal flow of water into the reservoir to replenish water loss through the leak in the system.

The invention includes a means to detect a fluid flowing in a portion of a particular fixture, means to time the duration of the fluid flow, measurement of the fluid flow duration to compare to a predetermined preprogrammed duration, and means to enable an alarm to notify the user. As an alternative, the means for alarm can activate a solenoid driven fluid valve to shut off the fixture experiencing the problem if desired by the user. The method of determining that the plumbing fixture has a problem is disclosed which includes measurement of fluid flow to the fixture as being outside a predetermined normal operating window of fluid flow duration for normal fill operations.

## BRIEF DESCRIPTION OF THE DRAWINGS

**Figure 1** is a partial perspective view of a toilet with the leak detection and warning system apparatus of the present invention installed thereon.

**Figure 2** is a schematic view of a tubular-shaped water flow detector used with

an embodiment of the present invention as depicted in **Figure 1**.

**Figure 3** is a schematic view of a tubular-shaped water flow detector used with an embodiment of the present invention as depicted in **Figure 1** with an alternate circuit plan.

5        **Figure 4** is a partial cross sectional view of the water flow detector as depicted in **Figure 2** wherein the conductive members of the detector exist as surface contact points inside the tube.

10       **Figure 5** is a cross sectional view of the water flow detector as depicted in **Figure 2** wherein the conductive members of the detector pass completely through the inside of the tube.

**Figure 6** perspective view of a urinal with the leak detection and warning system apparatus of the present invention installed thereon.

**Figure 7** is a top plan view of a water flow detector in the form of a flat strip used with an embodiment of the present invention as depicted in **Figure 6**.

15       **Figure 8** is a side view of a water flow detector of **Figure 7** wherein the strip-shaped water flow detector is essentially straight.

**Figure 9** is a side view of a water flow detector of **Figure 7** wherein the strip-shaped water flow detector is curved.

20       **Figure 10** is a circuit diagram for the electronic water flow detector, timer and alarm included in a preferred embodiment of the system of **Figure 1**.

**Figure 11** is a block diagram showing the step by step process of the fluid flow detection method disclosed.

**Figure 12** is a block diagram illustrating an alternative configuration of the invention used to shut a fluid input valve to a fixture.

## DETAILED DESCRIPTION OF THE INVENTION

5 In the following detailed description, like reference numerals will be used to refer to like or corresponding elements in the different figures of the drawings. The present invention couples a water flow detector **11** with a timer and alarm circuit **12** to detect a continuous and unintended water flow problem with a flush toilet or urinal. A preferred embodiment is disclosed in **Figure 1**, showing the basic internal components of a  
10 typical toilet.

The water flow detector **11** is a device that detects a continued flow of water past or through it. As depicted in **Figure 2**, this device is constructed of an insulating material **14** with a plurality of conductive members **13** mounted to the insulating material. In this particular embodiment depicted in **Figure 2**, the insulating material is  
15 formed into the shape of a tube. The conductive members **13** are aligned and the device is mounted at the end of the inlet refill tube **16** such that when water flows into the tank of a toilet through the inlet refill tube **16**, the incoming water passes over or through the detector **11**. The water passing in contact with the conductive members **13** will cause them to be electrically connected by virtue of the conductivity of the water.  
20 Water existing across the conductive members **13** essentially act as a switch. One or more of the conductive members **13** are connected to a power source **18** or ground source **17**. Thus, water that comes in contact with the conductive members **13**

connected to each side of the detector circuit will cause the normally open circuit to be closed.

Turning to **Figure 4** and **Figure 5**, one ordinarily skilled in the art can appreciate that the required conductive members **13** can take on various shapes provided that the passing water has adequate access to the surface of the conductive members.

Accordingly, **Figure 4** depicts an embodiment of the present invention such that the conductive members **13** exist as surface contact points inside the tube shaped insulating material **14**. In contrast, **Figure 5** depicts an embodiment of the present invention such that the conductive members **13** pass completely through the inside of the tube shaped insulating material **14**.

Turning to **Figure 6**, a depiction of a urinal with the leak detection and warning system apparatus of the present invention installed thereon is shown. The water flow detector **11** is mounted such that when water flows down the front wall **19** of the urinal, water flows over the detector **11**. Accordingly, the insulating material **15** to be used on the front wall **19** of a urinal might best be served in the form of a straight flat strip as shown in **Figure 8** or slightly curved strip as shown in **Figure 9**.

Turning now to **Figure 11**, the sequence of events in the method disclosed shall be described in detail. First, it is necessary that fluid flow detection **30** occur.

Measurement of the fluid flow is then timed to provide a duration of fluid flow **32**. The usefulness of the method comes in comparing the measured duration **32** against a preestablished desirable flow duration range **34**. The desirable flow duration window is measured usually in seconds and perhaps minutes. For a given fixture, the desirable

range would be the normal operating parameters of the fixture as installed when considering the input fluid flow duration to refill the fixture or otherwise replenish the fluids consumed in the operation of the fixture. In establishing such a desired duration range **34**, taken into account are such things as a short fluid flow run time which would indicate a partial refill because of a slow leak, or an over duration period indicating that the input valve or other mechanism to the fixture is stuck open or otherwise is not entirely completing its cycle causing the fixture to run in an on condition even though an overflow condition causing spillage may not exist. It can also be appreciated that in adjusting the desirable flow duration range **34**, a certain amount of additional time on both ends of the desirable time range window is desirable to prevent false alarms because of slight differences occurring because of the aging fixtures, a drop or increase in inlet fluid pressure, or other normal changes in operating parameters that would cause a slight change in the range of normal operation in day to day use.

If the duration of fluid flow **32** falls outside the normal operating duration range **34**, an alarm condition **36** exists. If an alarm condition **36** is tripped, an audible alarm **42** or other operation such as a command to close a fluid feed valve through a solenoid **40** can be the result. As an adjunct to the method, it can be appreciated that an external moisture condition **38** can also be used to enable the alarm condition range **36** to take desirable steps such as sounding an alarm or taking other action. External moisture conditions can include spillage of the fixture onto the floor or base of the fixture, or an overflow condition in the bowl of the fixture, all of which represent failures or conditions which may not be related to a stuck valve or other internal leak condition

that would be measured by the duration of fluid flow 32.

**Figure 11** is a block diagram showing basic component configuration for an alternative preferred embodiment of the present invention. Fluid flow sensor 11 provides its output parameters to duration detection and alarm system 46 which can drive a solenoid fluid valve 34 to close the fixture until service can be provided. As described above, an external moisture sensor 48 can be used as an accessory to the present invention to provide similar action in the event there is not a problem measured by the duration of the fluid flow to the fixture, but rather a spillage condition such as a clogged drain or other failure which may cause water spillage over the fixture onto the floor base or other parts of the fixture that normally would remain dry.

**Figure 10** shows a schematic of a typical alarm circuit and timer circuit that is coupled to the water flow detector 11. The timer circuit is constructed of commercially available components such as the 555 timer, which is used as a monostable multivibrator, and in this mode is essentially a one shot timer. Using this device, a resistor and capacitor combination is selected to create a pulse duration. The pulse duration is set to approximately two times the intended water flow period as designed to run in the flush cycle. In the event water continues to be detected by the water flow detector for a duration as long or longer than the pulse duration set up in the timer, the timer will output a time-out pulse. In order to generate a stable signal from the timer, the output pulse is connected to a flip-flop and the data output of the flip-flop is directed to the alarm circuit. To trigger the alarm, the output of the timer circuit - which for example is set to a logical 1 (high state) if the alarm is triggered - is connected to the



reset of the alarm circuit timer IC.

Using a 555 timer in an astable mode enables it to operate as an oscillator. In this fashion, the output is connected to a speaker to generate a buzz alarm tone of which the duration and tone emitted can be altered with the insertion of a capacitor connected within the positive side of the speaker connection. The 555 timer reset pin is connected to the output of the flip-flop such that when the flip-flop output is high, the alarm will sound.

In the automatic reset embodiment, the output of the water flow detector which is high when water flow is detected, is connected via an AND gate to the reset of the alarm circuit 555 chip. The output of the timer circuit flip-flop is the other input to the AND gate. Thus, when the timer circuit has timed out and water flow continues to be detected, the alarm will sound. When the water flow ceases to be detected, the alarm will cease to sound.

In the manual reset embodiment, a manual reset circuit contains a manual reset switch. Following the time-out, the alarm will sound whether water continues to flow or not. The reset switch is connected to ground on one side and to present or set pin of the flip-flop of the timer circuit. When pressed, the flip-flop is cleared and the signal to the alarm circuit goes low causing it to stop oscillating. Other timing circuits such as an oscillator and counter combination might be employed to measure the time period in which water runs.

The present invention may also be easily configured to react to undesirable intermittent water flow of the reservoir tank in certain instances of failure. Undesired intermittent water flow in a reservoir tank of a toilet may be caused by

several different factors. Such factors include a leaky flap seal which occurs sometimes because of the seal's age or poor condition; an improperly adjusted float valve which controls the inlet valve allowing fresh water to pass into the tank; the inlet valve malfunctions for various reasons or small cracks in the tank which allow water to leak slowly out of the tank or between a faulty seal thereby requiring the inlet valve to operate intermittently to refresh the tank water level.

In such cases of intermittent flow, the inlet valve opens for only a short period of time to compensate for the loss of water not related to an actual flush operation.

Because the duration of the flow is relatively short when compared to the duration of water flow related to a normal operating flush cycle, the present invention may employ a second timer circuit to detect such an occurrence. As can be appreciated by those skilled in the art, in such a situation the goal would be to detect that the duration of the water flow from the inlet valve into the tank is sufficiently less than what would be expected during a normal flush cycle.

A counter is added to count the number of times a "short flow" has occurred. Upon reaching a predetermined number of short flow occurrences, the counter would output a signal to which a latching operation would be associated. A latch circuit or other similar device would be connected to the alarm circuit in such a way to cause the alarm signal to activate and sound an alarm. In such a configuration, the present invention can provide an indication of a short flow run valve failure situation as described above allowing the owner to take appropriate action to repair the source of the problem.

In using the present invention in the immediately above described embodiment,

a water flow circuit is configured to provide the measurement of the events described above. Upon sensing the water flow, a water flow detector circuit sets a latch which is operatively connected to an intermittent flow timer circuit. The intermittent flow timer circuit begins a timing event in each instance. If the water flow ends prior to the end of the timer sequence, a latch signal is set causing a pulse to be sent to the counter causing it to increment. It can be appreciated by one skilled in designing such incrementing counting circuits that a circuit can be designed to increment or decrement depending on the particular design preferred. If multiple occurrences of a short time sequence occurs, thereby causing the counter to overflow (or underflow) its preset alarm limit, a pulse is outputted from the counter to a latch circuit which is operatively connected to the alarm circuit. Accordingly, the alarm will sound notifying the owner of a short cycle valve operation.

It would be a simple matter to provide for a separate alarm circuit which could be employed such that the sound emitted in response to an intermittent flow condition might be different from the sound emitted in response to a continued water flow failure such as a stuck valve or the like. Alternatively, the pulse or signal sent to the alarm circuit from the counter circuit output latch could be used to alter the sound emitted from the alarm circuit. Those skilled in the art can once again accomplish such an end result in a number of ways such as using the state of the signal to set a flip-flop device which divides the pulses being sent to the speaker thus creating a different tone. In the event the intermittent timer reaches its timed out value, which would be the case in a normal flushing cycle, a pulse is sent to the counter clearing it and thereby allowing the entire counting cycle to begin once again.

An alternate embodiment of the disclosed invention contemplates connection of the output of the timer circuit, or the intermittent water flow detector or both, with a central alarm system as are commercially available. The central alarm system being a device designed to monitor a plurality of alarm types and take a prescribed or  
5 programmed action upon the event of detecting an alarm on one of the connected inputs. Such connection could be hardwired or via radio frequency. The same connection from the output of the timer circuit, or the intermittent water flow detector or both, could be made to a computer via a computer network interface or direct  
10 connection to a computer via one on the many interface methods available on standard computer systems.

While the main advantage of the present invention is to provide notification when the fixtures water feed system is running too long or too short than necessary to meet the design requirements of the fixture, other alarm systems can be integrated in parallel with the existing device to add usefulness to the end user. For example, while there are  
15 other overflow detection systems described in the prior art, none of such systems address the flow rate measurement issue taught in the instant application. It would be useful, however, to add to the present device accessories which allow for both the measurement of the condition described in this specification, as well as measurement of overflow conditions if the plumbing fixture is clogged and water begins to overflow  
20 from the bowl or other reservoir as is sometimes observed. Such additional alarm conditions can include water or moisture sensors placed on the floor underneath the fixture, or a water level alarm at the top of the rear reservoir of the toilet fixture or the bowl itself. In this fashion, the advantages of the present invention can be combined

with more conventional moisture detection systems which only provide an alarm condition upon measuring moisture or water spillage where none normally would exist, during the proper operation of a fixture. Integration of the moisture sensor which would detect water levels or moisture conditions as described would be well known to those skilled in the art such that the integration of additional sensor inputs can be added to the alarm circuit to provide notification if an overflow condition exists. Such sensor could be placed on the floor behind or near the fixture. Other moisture sensors could be placed near the rim of a bowl or the reservoir tank of a fixture.

As an additional improvement or utility of the present invention, the alarm output generated by the detection of the period of time the water is flowing can be processed such as to drive a solenoid plumbing valve to shut off the water feed to the plumbing fixture which is leaking or for which the water feed is running too long. Aside from issuing an alarm condition to gain the attention of the homeowner, the output of the alarm can drive a solenoid valve so that water pressure to the fixture can be cut off automatically if desired. Such a solenoid driven valve is disclosed in prior art and is used for a variety of different plumbing fixtures to allow for valves to be opened or closed electrically without manual intervention. If a solenoid powered valve is utilized, it would require a separate power supply since the amount of current drawn by such solenoids is substantial enough to prevent them from being available to operate with small long-life batteries such as could be utilized in the alarm circuit disclosed.

In considering the alarm circuit disclosed in the present invention, it can also be appreciated that it may be convenient to provide a wireless alarm circuit whereby short range wireless components are utilized to allow the alarm output to be remotely located

in another physical location rather than the plumbing fixture being monitored. For example, many wireless alarm devices exist for use in remote control, home alarm circuits, outdoor indicators or other devices commonly available to the public which would allow the alarm condition generated by the invention to be transmitted remotely, a short distance, to a receiver located in a more convenient location for the user of the device. Short range devices are used which are employed from anything such as baby monitors, garage door open condition indicators, mailbox mail delivery indicators and other simple consumer-type devices could easily be employed with the plumbing fixture to be communicated to another location in the building at the discretion of the user. Indeed, in a commercial installation such as an apartment rental, office building or the like, management of the premises may wish to have such an alarm condition communicated to them remotely via an internet connection or some other communication system possibly wired to a variety of similar detectors in a bank of plumbing fixtures such as may be found in a large building restroom or the like.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art. It is intended that the claims presented herewith be interpreted to cover such modifications and equivalents.